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Luciogobius adapel, a New Species of Gobiid Fish from Japan

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Abstract *Luciogobius adapel* is described, based on five specimens, 19.0–31.5 mm SL, from a depth of 20–50 m in North to Central Japan. It is unique among gobioids in lacking dorsal, anal and pelvic fins, but is considered as the most reductive member of *Luciogobius* sensu lato. Its osteology is described in detail, and definition of the genus is briefly discussed.

Key words: Gobiidae, *Luciogobius adapel*, new species, Japan, multiple fins absence

Introduction

Fishes of the genus *Luciogobius* Gill, 1859 (Teleostei; Gobiidae) are endemic to north-eastern Asian waters and are particularly speciose in Japanese waters. The species are readily distinguished from other gobioids, except those in *Leucopsarion*, by the absence of the first dorsal fin. Except for *L. brevipterus* Chen and *L. martellii* Di Caporiacco described from China (Chen, 1932; Di Caporiacco, 1947), twelve species of *Luciogobius* have been known from various shallow, cryptobenthic habitats around Japan, including inshore to subterranean waters (Yatou, 1998; Akihito *et al.*, 2000). About 24 species of *Luciogobius* remain to be described (Aizawa, pers. comm.). Various authors have recognized *Expedio* Snyder, 1909, and *Inu* Snyder, 1909 as valid genera for some species of *Luciogobius*. Akihito *et al.* (2000) considered these two genera synonymous with *Luciogobius*.

This paper describes a remarkable new species of the *Luciogobius* (sensu Akihito *et al.*, 2000), which lacks dorsal, anal, and pelvic fins, based on five specimens collected from the northernmost to central parts of the Japanese mainland. This lack of fins is unusual among gobioids, thus its osteological features are described in detail. Terminolgy for skeletal structures follows that of Springer (1983), except for epural ribs defined by Patterson & Johnson(1995).

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Luciogobius adapel sp. nov.

[Kawari-mimizuhaze: new Japanese name]

(Figs. 1–3)

Material. Holotype—NSM-P (National Science Museum) 59610. 27.5 mm SL; collected by Smith-McIntyre grab at depth of about 20m off Imabetsu, Aomori Pref. Japan (41°–11′N, 140°–29′E), on August 29, 1983.

Paratypes—NSM-P 59611. 31.5 mm SL, collected with holotype; cleared and counter stained. NSM-P 59612. 19.0 mm SL; USNM 365136. 39.8 mm SL; same locality as holotype, August 1983.

FRLM 21099. 29.3 mm SL; collected by dredge at depth of about 50 m off Shima Peninsula, Mie Pref. Japan (34°–11.8′N, 136°–49.4′E), on August 21, 1997.

Comparative materials: *Luciogobius parvulus*, 30.5 mm SL (alizarin stained), Nomo, Nagasaki Pref.; *Luciogobius guttatus*, 34 mm SL (counterstained), Yuya Bay, Yamaguchi Pref.

Diagnosis. A species of *Luciogobius* with the following combination of characters: lacks dorsal, anal, pelvic fins and dorsal- and anal-fin pterygiophores; pelvic-fin girdle only ossified posteriorly; vertebrae including hypural plate 23+26−27= 49−50, more than in any other species of *Luciogobius*; and the smallest number of pectoral rays 9–10, fewer than in any other species of *Luciogobius*, except *L. elongates* which has 8.

Description. Counts and proportional measurements are given in Table 1. Body very elongate, little compressed laterally. Head small, snout rounded in dorsal view; eyes small but not vestigial, slightly elliptical longitudinally, located in anterior one-third and near top of head; interorbital narrow, its bony width 1/3 to 1/4 eye diameter; snout slightly longer than eye, nostrils widely separated at snout tip and nearly in contact with anterior margin of eye. Mouth slightly oblique; jaws reach posteriorly to vertical through posterior edge of eye. Gill opening small, restricted to side of head at level of pectoral-fin base. Single row of closely spaced canine-like teeth ex-

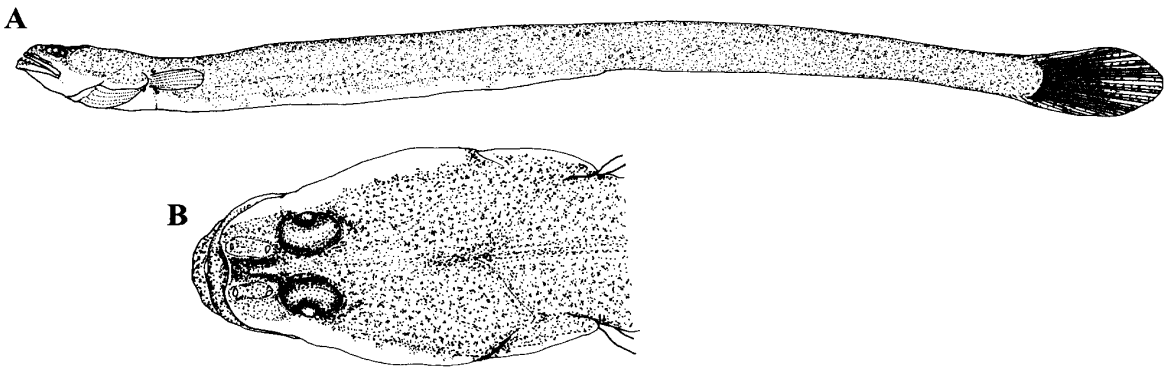

Fig. 1. *Luciogobius adapel*, NSMT-P59610, holotype, 27.5 mm SL, Aomori Prefecture. —— A: Lateral view; B: Dorsal view of head.

Table 1. Counts and measurements of *Luciogobius adapel*.

	NSMT-P59610*	NSMT-P59611	USNM 365136	NSMT P59612	FRLM 21099
Standard length, mm	27.5	31.5	39.8	19.0	29.3
Dorsal, anal, pelvic rays	0	0	0	0	0
Pectoral rays (L-R)	9–9	9–10	9–9	10–10	10–10
Caudal rays	6+6+5+6	7+6+5+7	8+6+5+7	7+6+5+7	?+6+5+?
Vertebrae		23+26=49			23+27=50
As % standard length:					
Head length	12.0	11.9	12.6	14.7	13.7
Head width	6.36	7.46	7.30	7.90	6.48
Body depth (Pf base)	4.36	4.76	5.02	2.26	5.12
Pecotral-fin length	5.56	4.60	4.52	5.53	6.14
Caudal-fin length	10.7	11.7	9.54	12.6	5.8+
Preanus length	52.7	57.1	56.5	56.8	56.7
As % head length:					
Eye diameter	14.5	13.3	14.6	16.7	13.8
Interorbital length	27.2	29.8	25.0	30.0	26.3
Upper jaw length	35.7	38.8	35.8	38.6	37.5
Snout length	21.4	19.0	20.0	21.8	18.8

* holotype.

tend length of premaxillary; similar but slightly larger and more widely spaced teeth on anterior two-thirds of dentary; all other teeth restricted to pharyngobranchials. Anus slightly posterior to midbody. Urogenital papilla indistinct, thus sex unknown. Caudal fin rounded posteriorly; principal rays deeply branched and segmented; remaining rays either segmented or not. Pectoral fin small, a little elevated on body, base narrow; all rays segmented, and moderately branched except dorsal- and ventral-most. Lateral line and scales completely lacking. Sensory papillae of head (Fig. 2) poorly developed except for those around jaws which are crowded and irregularly arranged; those in other parts widely spaced, but mostly aligned in rows; dermal ridge below eye indistinct.

Coloration of specimens in alcohol. Lower half of head, including branchiostegal membranes, and continuing on ventral surface of trunk unpigmented, remainder of uniformly brown with densely scattered melanophores. Pectoral fins unpigmented, proximal half of caudal fin finely spotted, remainder immaculate.

Osteology. Osteological features are described based on the paratype (NSM-P 59611).

Jaws, suspensorium, superficial bones (Fig. 3A): Premaxilla well developed with relatively long ascending process; maxilla slender, in close contact with anterior head of palatine; no supramaxilla. Lower jaw comprising denatary, anguloarticular and

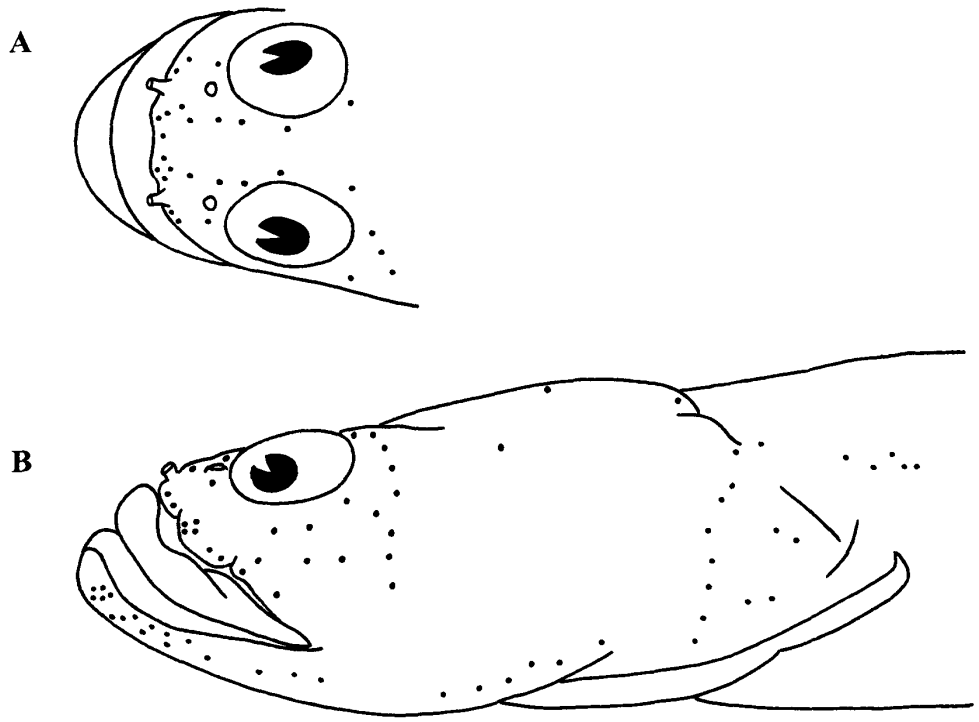

Fig. 2. Positions of cephalic sensory organ in *Luciogobius adapel*, NSMT-P 59610, holotype. —— A: Dorsal view (in part); B: Lateral view.

retroarticular; dentary gradually expanded posteriad, with nearly vertical end; anguloarticular deeply forked with arms of similar length, but ventrally more expanded; retroarticular on medial surface of articular without coronomeckerians; ectopterygoid contacts only midportion of anterior edge of quadrate; mesopterygoid absent. Whole suspensorium extended longitudinally. Hyomandibula large, irregularly elongated with foramen at anteroventral corner; quadrate deeply and narrowly forked with longer posterior arm where symplectic tightly inserts. All opercular bones elongated, similar in size; metapterygoid rodlike, intervening between anterior arm of quadrate and anteroventral corner of hyomandibula; no connection between symplectic and hyomandibula. Lacrymals absent.

Gill arches (Fig. 3B): Infraharyngobranchial absent, all gill-arch elements ossified, except basibranchials 1 and 4, which are cartilaginous; basibranchial 3 extremely small, lying between tips of hypobranchials 3, widely separated from basibranchial 4; ceratobranchial 5 curved posterolaterally, with large medial toothplate covering throughout most of its length; infrapharyngobranchials 2–4 bear small or moderate tooth plates. Basihyal deeply concaved anteriorly. Gill rakers and pseudobranch absent.

Hyoid arch (Fig. 3C): Interhyal small, rodlike, its upper end lying close to juncture between hyomandibula and preopercle, distant from symplectic. Anterior cerato-

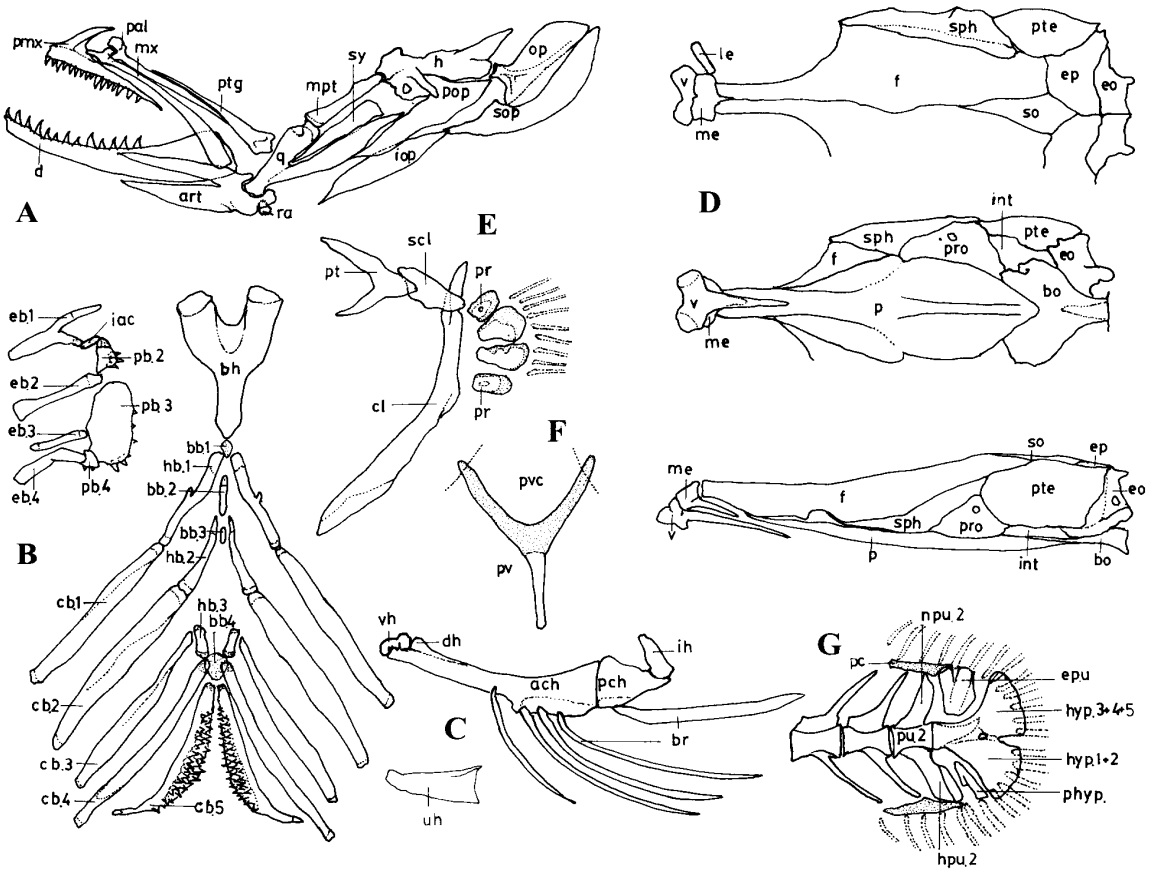

Fig. 3. Osteology of *Luciogobius adapel*, NSMT-P59611, paratype. —— A: Jaw and suspensorium, B: Gill arch, C: Hyoid arch, D: Cranium, E: Pectoral girdle, F: Pelvic girdle, G: Caudal skeleton. ach: anterior ceratohayal, art: anguloarticular, bb 1–4: basibranchials 1–4, bh: basihyal, bo: basioccipital, br: branchiostegals, cb 1–5: ceratobranchials 1–5, cl: cleithrum, d: dentary, dh: dorsalhypohyal, eb 1–4: epibranchials 1–4, eo: exoccipital, ep: epioccipital, epu: epural, f: frontal, h: hyomandibula, hb 1–3: hypobranchials 1–3, hyp 1–5: hypurals 1–5, iac: interarcual cartilage, ih: interhyal, int: intercalary, iop: interopercle, le: laterl ethmoid, me: medianethmoid, mpt: metapterygoid, mx: maxilla, op: opercle, p: parasphenoid, pal: palatine, pb 2–4: infrapharyngobrnchials 2–4, pc: procurrent cartilage, pch: posterior ceratohyal, phyp: parhypural, pmx: premaxilla, pop: preopercle, pr: proximal radial, pro: prootic, pt: posttemporal, pte: pterotic, ptg: ectopterygoid, pu 2: preural vertebra 2, pv: pelvis, pvc: pelvic intercleithral cartilage, q: quadrate, ra: retroarticular, scl: supracleithrum, so: supraoccipital, sop: subopercle, sph: spehnotic, sy: symplectic, uh: urohyal, v: vomer, vh: ventral hypohyal.

hyal elongate, slightly expanded posteriad; posterior ceratohyal nearly triangular, pointed posteriorly. Branchiostegals five; four on anterior ceratobranchial slender, slightly curved, anteriormost articulating with lateral surface of narrow portion and three articulating with posterior half of expanded posterior portions and ceratobranchial; one posteriormost branchiostegal straight, bladelike, articulating near anteroventral corner of ceratobranchial. Ventral hypohyal distinct, lying just in front of anterior ceratohyal; dorsal hypohyal largely fused with anterodorsal margin of anteri-

or ceratohyal. Urohyal simple splint with slightly curved posterior edge.

Cranium (Fig. 3D): Cranium slender and elongate, depressed without marked projections or complicated sutures. All bones ossified; no elements fused or degenerate except for absence of parietal, difinitive for gobioids. Frontal large, covering more than half of cranial roof. Nasal bones and rostral cartilage absent.

Pectoral girdle (Fig. 3E): Posttemporal, supracleithrum and cleithrum well ossified; scapula and coracoid completely absent. Proximal radials four, all cartilaginous peripherally; dorsalmost and ventralmost nearly ovoidal, less ossified with small perforation anteriad; middle two slightly larger, bearing fin rays along most of their posterior border.

Pelvic girdle (Fig. 3F): Simple Y shape bone lacking fin rays; anterior V part (tentatively termed as pelvic intercleithral cartilage) meeting cleithrum slightly dorsad to isthmus; posterior rod (pelvis) ossified without longitudinal slit.

Vertebrae (not illustrated) and caudal skeleton (Fig. 3G): Vertebrae 23+26=49, well ossified; parapophyses on all precaudal vertebra; vertebrae 3–22 bear pleural ribs, which gradually change direction from lateral to ventroposteriad at around vertebra 8; epineural ribs absent. Dorsal and anal fin rays and pterygiophores entirely absent. Caudal skeleton reduced, hypurals fused with urostyle into single complex; hypural 5 (distinct in other congeners) either fused or absent. Shallow V-shaped notch between dorsal and ventral hypural plates with small foramen just anterior; parhypural small, free, between hpu2 and ventral hypural plate; epural single, large, irregular in shape with deep notch dorsally. Elongate dorsal and ventral procurrent cartilages present, each supporting 4 or 5 procurrent rays; these termed as 'CINPU3+CPEP1' and 'CIHPU3' (sensu Fujita, 1990) respectively; only proximal halves of principal caudal rays ossified.

Etymology. Species name is acronym of three fins; dorsal (d), anal (a) and pelvic (pel) with the prefix meaning absence (a-).

Remarks. The combined absence of dorsal, anal, and pelvic fins is unknown among other gobioid fishes and is uncommonly reported in other acanthomorphs (i.e., some synbranchid eels). The gobioid affinities of the new species are clearly indicated, however, by its lacking parietals and a basisphenoid, and in its having basibranchial 1 cartilage. Its gobiid affinities are indicated, in general, by the presence of only 5 branchiostegals. Among the gobiids, it appears to be assignable to *Luciogobius* Gill (sensu lato), which includes elongate species with small, sometimes subcutaneous vestigial eyes on top of depressed heads that lack first dorsal fins and have reduced or no pelvic fins (i.e., *L. parvulus*; Akihito *et al.*, 2000).

Aside from the complete absence of dorsal and anal fins, *L. adapel* differs from all the other species of *Luciogobius* in having more vertebrae (49–50 vs 30–45), and generally differs in having fewer pectoral-fin rays (9–10 vs 12–19, except 8 in *L. elongates*). The number of pectoral-fin rays is probably associated with the overall reduced structure of the girdle, which lacks scapula and coracoid, a condition it shares

with *L. parvulus*; *L. guttatus*, which have 18 pectoral-fin rays, have both, scapula and coracoid. *Luciogobius adapel* also has the least developed pattern of cephalic sensory organs, compared with 9 congeners (Akihito *et al.*, 2000).

Highly specialized features of *Luciogobius* (s.l.) including reductive trends mentioned above, have caused confusions in systematic studies that have chiefly addressed to *Luciogobius*, *Expedio* and *Inu*. Monotypic *Expedio* established on account of lacking the pelvic fins (Snyder, 1909), has been placed in the synonymy of *Luciogobius* by many authors (e.g., Tomiyama, 1936; Regan, 1940; Arai, 1981; Aizawa, 1997; Akihito *et al.*, 2000), because pelvic fins in the latter are sometimes vestigial or highly reduced, thus their loss being unqualified in generic definition. *Inu* discriminated from related genera primarily in having the partly scaled body (Snyder, 1909) has also been subjected to the generic problem. For example, Arai (1981) suggested to transfer a naked goby, *Luciogobius saikaiensis*, from *Luciogobius* to *Inu*, because (1) *Inu* and putatively related *Clariger* show variable degrees of reduction in squamation including the absence in the latter, and (2) *L. saikaiensis* have some distinct characters shared with *Inu*, such as the smallest vertebral counts of 31–33, presence of dark brown stripe along the caudal-fin base, and insertion of the first dorsal-fin ray pterygiophores in advance of those of the first or second anal-fin rays. Subsequent study revealed that these characters given in (2) were not always peculiar to *Inu* (Akihito *et al.*, 1988).

Taking such a considerable variability into consideration, the recognition of *Expedio* and *Inu* as distinct genera cannot be justified, so that *Luciogobius* (s.l.) is a natural grouping to accommodate all these variable species including *L. adapel*. In addition, all the known larvae of *Luciogobius* (s.l.) seem to share a characteristic melanophore series which comprise a longitudinal row over the head from the snout across the eye to the operculum, and small to large middorsal dots regularly spaced in the trunk (Shiogaki & Dotsu, 1988). These ontogenetic evidences may substantiate this generic placement.

As is common with most gobioids, information on *Luciogobius* interrelationships is inadequate, despite its peculiar features. Birdsong *et al.* (1988) tentatively included *Luciogobius*, in *Astrabe* Group (Gobiidae; Gobiinae) along with other genera (*Astrabe*, *Clariger*, *Eutaenichthys*, *Typhlogobius* and *Leucopsarion*) chiefly on the basis of the vertebral column and median fin osteology. Harrison (1989) included two species of *Luciogobius* in his comparative studies on gobioid palatopterygoquadrate complex comprising 165 species. Although he failed to find a sister taxon for *Luciogobius* based on the characters he studied, he suggested its possible relationship with *Clariger*, based on other sources of information. This information seems to suggest that *Luciogobius* is a highly specialized gobiid genus that has acquired many innovative characters, the extreme of which are seen in *L. adapel*. In this connection, it is interesting to note that species group of *Luciogobius* with distinct reductive trends in fin characters possess higher numbers of vertebrate and elongate body (e.g., Arai,

1981; Akihito *et al.*, 1988), which are also culminated in *L. adapel*.

The ecological importance of these specialization is difficult to interpret. As Regan (1940) suggested that pelvic fin reduction in *L. elongatus* and loss in *L. parvurus* may perhaps be related to burrowing habits, the cryptobenthic modes of life of *Luciogobius* species in a demanding environment are probably involved. Exceptionally deeper occurrence of *L. adapel* as attaining 20–50 m seems to imply possible association between ecological isolation in the less competitive habitat and the evolution of this unusually specialized morph.

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